REMARKS

Claims 1-6 and 8-11 are all the claims presently pending in the application. By this amendment, the abstract and claims 1, 3-4, and 8 are amended, claim 7 is canceled without prejudice or disclaimer, and new claims 9-11 are added. No new matter has been introduced.

It is noted that the claim amendments, if any, are made only to assure grammatical and idiomatic English and improved form under United States practice, and are not made to distinguish the invention over the prior art or narrow the claims or for any statutory requirements of patentability. Further, Applicant specifically states that no amendment to any claim herein should be construed as a disclaimer of any interest in or right to an equivalent of any element or feature of the amended claim.

The Examiner objects to the abstract, claims 3-5, and Figures 5-6 and 8-9 of the drawings. Although Applicant submits that all claims were clear as originally recited, the claims and abstract have been amended and replacement drawing sheets are submitted to obviate this objection. Applicant respectfully requests the Examiner reconsider and withdraw the objections to the abstract, claims 3-5, and the drawings.

Applicant appreciates the Examiner's indication that claim 5 would be **allowable** if rewritten in independent form. However, for at least the reasons discussed below, Applicant believes that all claims are patentable.

Claims 1-6 stand rejected under 35 U.S.C. §112, second paragraph. Claim 7 stands rejected under 35 U.S.C. §102(e) over Hunton (US 7,170,952). Claims 1-4 and 6 stand rejected under 35 U.S.C. §103(a) over Long, et al. (US 5,710,990) in view of Birchler, et al. (US 5,638,403). Claim 8 stands rejected under 35 U.S.C. §103(a) over Hunton in view of Long and Birchler.

The rejections are respectfully traversed in the following discussion.

THE CLAIMED INVENTION

The claimed invention, as exemplarily defined in claim 1, is directed to an amplitude limiting circuit. The amplitude limiting circuit limits an amplitude of a signal input to a power amplifier. The amplitude limiting circuit has an amplitude converter, a determination unit, a pead detector, a window filter, a delay circuit, and a multiplier.

The amplitude converter calculates an amplitude value of an input signal.

The determination unit detects, as a detection interval, an interval in which the amplitude value exceeds a threshold, on the basis of a preset threshold and the amplitude value of the input signal.

The peak detector detects, in the detection interval, a peak time when a maximum amplitude value appears and an amplitude value at the peak time as a peak value.

The window filter generates a window function for limiting the amplitude value to a value not more than the threshold by using the peak value output from the peak detector.

The delay circuit delays the input signal such that the peak time output from the peak detector coincides with time when the window function output from the window filter exhibits a minimum value.

The multiplier multiplies an output signal from the delay circuit by the window function.

In conventional digital mobile communication systems, CDMA (Code Division Multiple Access) communication apparatuses are used to improve the interference resistance ability between communication channels. In a CDMA communication apparatus, because the

instantaneous power at the time of transmission is much higher than the average power, the linearity of a transmission power amplifier must be maintained up to a very high output level to suppress spreading of a transmission spectrum due to nonlinear distortion so as to reduce adjacent channel leakage power.

A power amplifier designed to have good linearity up to a very high amplitude has a large circuit size, and hence increases in cost and power consumption. For this reason, as a transmission power amplifier for a CDMA communication apparatus, a nonlinear compensation amplifier is used, which exhibits good linearity with respect to small amplitude components and nonlinearity with respect to large amplitude components. The linearity of this nonlinear compensation amplifier has the input/output characteristics that linearity is maintained up to its maximum output, and when an input amplitude exceeds a value corresponding to the maximum output, the output level becomes constant.

When a signal corresponding to a level exceeding the maximum output is input, a transmission output is saturated to increase nonlinear distortion. As a consequence, the transmission spectrum spreads to increase adjacent channel leakage power.

It is important in the CDMA communication apparatus that the instantaneous maximum power of an input signal is limited so as not to exceed the saturation power of the transmission power amplifier.

The simplest method of limiting the input amplitude of the transmission power amplifier is to clip an input signal with a predetermined value. If, however, an input signal is simply clipped, the nonlinear distortion of a signal waveform increases. As a result, the transmission spectrum further spreads. Therefore, an amplitude limiting circuit is generally provided before a band limiting filter.

An amplitude limiting circuit includes an amplitude converter which calculates the amplitude value of an input signal constituted by an in phase component I and quadrature component Q, a determination unit which compares the amplitude value calculated by the amplitude converter with a preset threshold to output a control value for limiting the amplitude of an input signal that exceeds the threshold, and a clipping circuit which limits an output amplitude to a value equal to or less than the threshold in accordance with the control value output from the determination unit.

Of an output signal from the amplitude limiting circuit, only a predetermined baseband component is output from a filter. In this arrangement, since the frequency component of an output signal is limited by the filter within a predetermined band, the transmission spectrum does not spread.

However, since the amplitude limiting circuit and filter differ in their sampling rates for signal processing, level variations occur at the time of sampling. As a result, the amplitude of the signal passing through the filter 24 may increase again.

In addition, when the amplitude limiting circuit is applied to a CDMA communication apparatus of a so called multicarrier amplification scheme of combining a plurality of carrier signals, the amplitude of the signal is increased again by processing after amplitude limitation.

The CDMA communication apparatus includes a plurality of amplitude limiting circuits which limit the amplitudes of input signals and a plurality of filters which pass only predetermined band components.

The CDMA communication apparatus also includes first frequency converters which convert input signals as baseband signals into signals having different frequencies for

the respective channels, and a carrier combining unit which combines output signals from the first frequency converters.

The CDMA communication apparatus further includes a D/A converter which converts the signal obtained by carrier combining into an analog signal, a second frequency converter which converts the output signal from the D/A converter into an RF signal, and a transmission power amplifier which amplifies the RF signal to power necessary for transmission.

The CDMA communication apparatus includes the amplitude limiting circuits, filters, and first frequency converters for the respective channels. In this arrangement, since signals corresponding to a plurality of channels are subjected to vector combining in the carrier combining unit after amplitude limitation, the effect of the amplitude limitation is lost. As a consequence, the transmission spectrum spreads.

The present invention, on the other hand, provides an amplitude limiting circuit which can be effectively used to limit an input to a transmission power amplifier incorporated in a CDMA communication apparatus. Further, the present invention provides a CDMA communication apparatus free from nonlinear distortion which is caused when a transmission output from the transmission power amplifier on the output stage is saturated, and hence spreading of a transmission spectrum is suppressed. The present invention thus suppresses adjacent channel leakage power.

THE PRIOR ART REJECTIONS

The Long and Birchler Reference

The Examiner alleges that certain features of claims 1-4 and 6 are disclosed by Long, et al., in view of Birchler. Applicant respectfully traverses this rejection.

The Examiner admits in the Office Action that Long fails to disclose or suggest a "*determination unit which detects, as a detection interval, an interval in which the amplitude value exceeds a threshold, on the basis of a preset threshold and the amplitude value of the input signal; a window filter which generates a window function for limiting the amplitude value to a value not more than the threshold by using the peak value output from the peak detector; and a multiplier which multiplies an output signal from the delay circuit by the window function.*" Office Action, p. 6. Birchler fails to overcome this deficiency of Long.

Specifically, Birchler fails to disclose or suggest, "a determination unit which detects, as a detection interval, an interval in which the amplitude value exceeds a threshold, on the basis of a preset threshold and the amplitude value of the input signal," as recited in the claim.

The Examiner alleges that Birchler discloses, "*a windowed-clipping algorithm that provides a low-splatter mechanism of reducing signal peaks by applying an attenuating window, such as an inverse Hanning window, to a limited number of signal samples centered at the peak of a signal above a clip threshold. A timing diagram of an input signal having a local maximum at time Tmax above a predetermined clip threshold.*" Office Action, p. 6.

Birchler discloses only, "*The windowed-clipping algorithm provides a low-splatter mechanism of reducing signal peaks by applying an attenuating window to a limited number of signal samples centered at the peak of a signal, which peak is above a clip threshold. An*

additional threshold, set below the clip threshold in magnitude, is used to determine which peaks should have the windowed-clipping algorithm applied to them. Additional points for the input signal are generated by interpolating additional values around a signal peak at a higher rate than the signal samples were taken. Similarly, the values for the attenuating window are also calculated at the higher rate at which interpolation is performed. The higher-rate attenuating window is aligned to the samples and interpolated values for the input signal, and windowed-clipping is performed." Birchler, col. 5, lines 38-52. "*When the value having the highest magnitude is above the second threshold, an attenuating window is centered at the value having the highest magnitude and applying the attenuating window to at least some of the plurality of input samples.*" Birchler, col. 5, line 65 – col. 6, line 2. "*A set of local attenuating values separated in time by one over the first rate is determined, yielding the attenuating window. The attenuating window is aligned with the aligning sample. The attenuating window is applied to at least some of the plurality of input samples.*" Birchler, col. 6, lines 11-15.

Thus, Birchler fails to disclose or suggest a determination unit which detects, as a detection interval, an interval in which the amplitude value exceeds a threshold, as recited in the claim. Instead, Birchler discloses only detecting input samples and applying an attenuation window to a discrete number of input samples.

Thus, turning to the clear language of the claim, Long, alone and in combination with Birchler, fails to disclose or suggest all features of independent claim 1. Applicant respectfully requests withdrawal of the rejection of claim 1 over Long in view of Birchler.

Claims 2-6 are dependent on claim 1, and inherit all features and limitations thereof. Applicant submits that claims 2-6 are patentable for at least this reason, as well as for the

additional features they recite.

With further regard to claim 2, the Examiner alleges that Birchler teaches, "*that there are two modes of operation of the windowed-clipping algorithm, variable and constant. If $|p(n)|^2$ is greater than Tclp, but less than Tsat (criterion 1), and is determined to be a local maximum (criterion 2), a variable window calculation is triggered.*" Office Action, p. 7.

However, Birchler discloses only a variable severity of windowed clipping. Birchler, col. 3, line 10 – col. 4, line 32. Birchler fails to disclose or suggest an interval detecting section which detects an interval in which the amplitude value exceed the threshold, as recited in the claim.

With further regard to claim 3, the Examiner alleges that Birchler teaches, "*the two conditions that trigger a variable window calculation,*" and, "*form figure 2 we can see that the window value is 1 before and after the correction interval.*" Office Action, p. 8.

However, Birchler failes to disclose or suggest wherein the window function "exhibits a value of 1 before and after a preset correction interval longer than the detection interval," as recited in the claim.

Instead, as discussed above, Birchler fails to disclose or suggest a detection interval. Further, because Birchler fails to disclose a detection interval, Birchler necessarily must fail to disclose or suggest a preset correction interval being longer than the detection interval. Instead, Birchler discloses only a window function being applied to a number of inputs which exceed the threshold.

With further regard to claim 4, the Examiner alleges that Birchler teaches, "*the two conditions that trigger a variable window calculation,*" and, "*form figure 2 we can see that the window value is 1 before and after the correction interval.*" Office Action, p. 8.

However, Birchler failes to disclose or suggest wherein the window function "exhibits a value which is 1 until the peak value and becomes not more than a value (threshold/peak value) at the center of the correction interval after the peak time," as recited in the claim.

Instead, Birchler figure 2 clearly discloses a window function wherein the value decreases below 1 prior to the peak value. Birchler further fails to disclose or suggest wherein the window function becomes not more than a value (threshold/peak value) at the center of the correction interval.

With further regard to claim 6, the Examiner alleges that Long teaches, "*a threshold input section which inputs a threshold to the determination unit (see figure 1 box 56, threshold detector, the threshold found here will be feed to the determination unit of Birchler).*" Office Action, p. 8.

However, Long fails to disclose or suggest "a threshold input section which inputs a threshold to said determination unit," as recited in the claim. Instead, Long figure 1, ref. 56, is a threshold detector. Birchler does not lack threshold detection.

Further, no reference is cited which teaches or suggests combining Birchler with Long in the suggested manner. Thus, even assuming, *arguendo*, that Long in view of Birchler disclosed all features of a claim, such a combination would still constitute improper hindsight use of Applicant's disclosure.

Applicant respectfully requests the Examiner reconsider and withdraw the rejections of claims 1-4 and 6 over Long in view of Birchler.

The Hunton Reference

Claim 7 stands rejected under 35 U.S.C. §102(e) over Hunton. Claim 8 stands

rejected under 35 U.S.C. §103(a) over Hunton in view of Long and Birchler, discussed above. Applicant respectfully traverses these rejections.

The Examiner alleges that all features of claim 7 are disclosed in Hunton. Claim 7 is canceled without prejudice or disclaimer. Thus, the rejection of claim 7 is mooted.

Claim 8 is amended to include all features and limitations of original claim 7, from which claim 8 previously depended. The Examiner alleges that all features of claim 8 are disclosed in Hunton, Long, and Birchler. However, Applicant submits that there are features of the claimed invention which are neither disclosed nor suggested by Hunton, Long, or Birchler.

Specifically, Hunton, alone and in combination with Long and Birchler, fails to disclose or suggest wherein, "said delay circuit delays said input signal by a lapse time τ, where τ comprises a value set in advance to half a value corresponding to a time longer than an interval in which said input signal exceeds said threshold," as recited in the claim.

The deficiencies of Long and Birchler are discussed above. Hunton fails to overcome these deficiencies.

Instead, Hunton discloses only a delay, "*equal to filter delay.*" Hunton, Fig. 6. "*The correction filter will time delay the correction signal stream VC requiring a matching time delay, provided by time delay circuit 120, to signal stream S prior to signal combination with VF. Time delay circuit 120 should also include any additional delays associated with the correction signal path, e.g., such as due to algorithm processor 140.*" Hunton, col. 6, lines 51-57.

Thus, turning to the clear language of the claim, Hunton, alone and in combination with Long and Birchler, fails to disclose at least this feature of claim 8.

Further, no reference is cited which teaches or suggests combining Hunton with Long and Birchler in the suggested manner. Thus, even assuming, *arguendo*, that Hunton in view of Long and Birchler disclosed all features of the claim, such a combination would still constitute improper hindsight use of Applicant's disclosure.

Thus, Applicant respectfully requests the Examiner reconsider and withdraw the rejections of claim 8 over Hunton in view of Long and Birchler.

CONCLUSION

Replacement sheets are submitted herewith for Figures 5-6 and 8-9.

In view of the foregoing, Applicant submits that claims 1-6 and 8-11, all the claims presently pending in the application, are patentably distinct over the prior art of record and are allowable, and that the application is in condition for allowance. Such action would be appreciated.

Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned attorney at the local telephone number listed below to discuss any other changes deemed necessary for allowance in a telephonic or personal interview.

To the extent necessary, Applicant petitions for an extension of time under 37 CFR §1.136. The Commissioner is authorized to charge any deficiency in fees, including extension of time fees, or to credit any overpayment in fees to Attorney's Deposit Account No. 50-0481.

Respectfully Submitted,

Date: 21 June 2007

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Motoya IWASAKI

Serial No.: 10/642,614

Group Art Unit: 2616

Filed: August 19, 2003

Examiner: Mui, Gary

For: AMPLITUDE LIMITING CIRCUIT AND CDMA COMMUNICATION APPARATUS

Honorable Commissioner of Patents
Alexandria, Virginia 22313-1450

SUBMISSION OF REPLACEMENT DRAWING SHEETS INCLUDING PROPOSED DRAWING CORRECTIONS

Sir:

Submitted herewith are replacement drawing sheets including proposed drawing corrections to Figures 5-6 and 8-9 in response to an Office Communication dated April 3, 2007. If approved, such corrections will be incorporated into the formal drawings at the time of allowance.

Approval and acknowledgment of receipt are respectfully requested.

Respectfully Submitted,

Date: 21 June 2007

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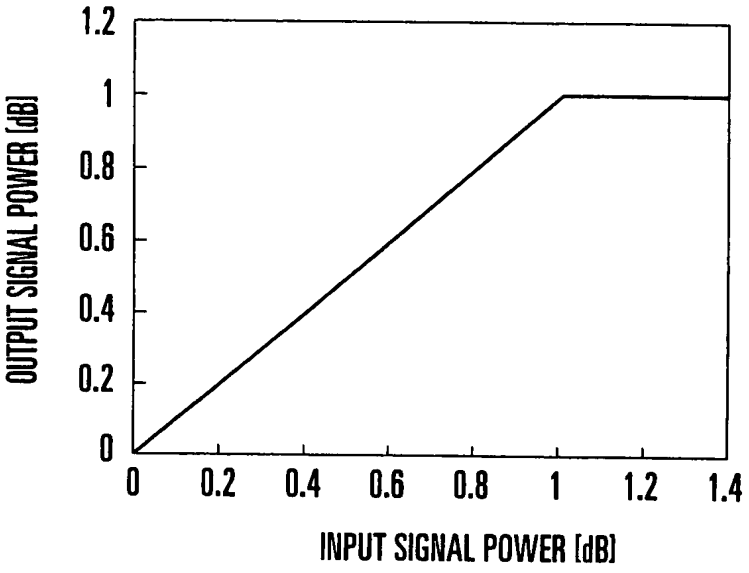

FIG. 5

PRIOR ART

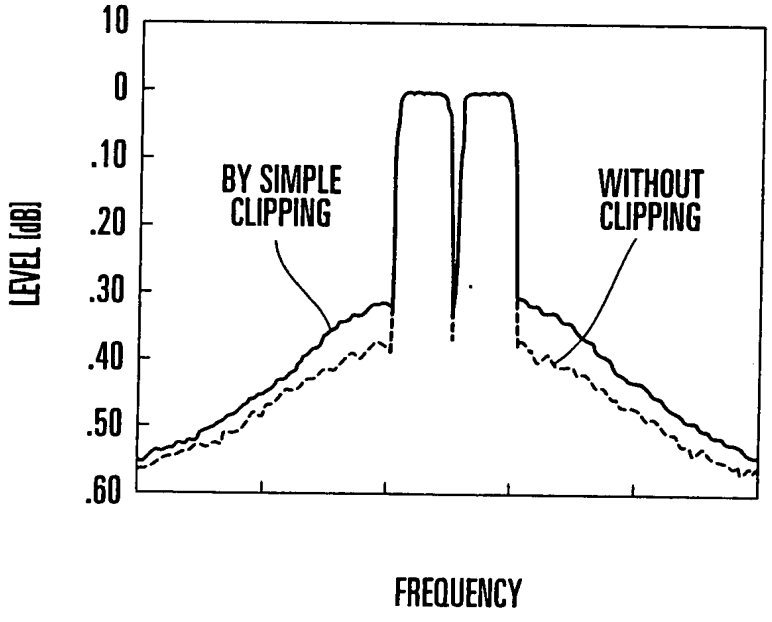

FIG. 6

PRIOR ART

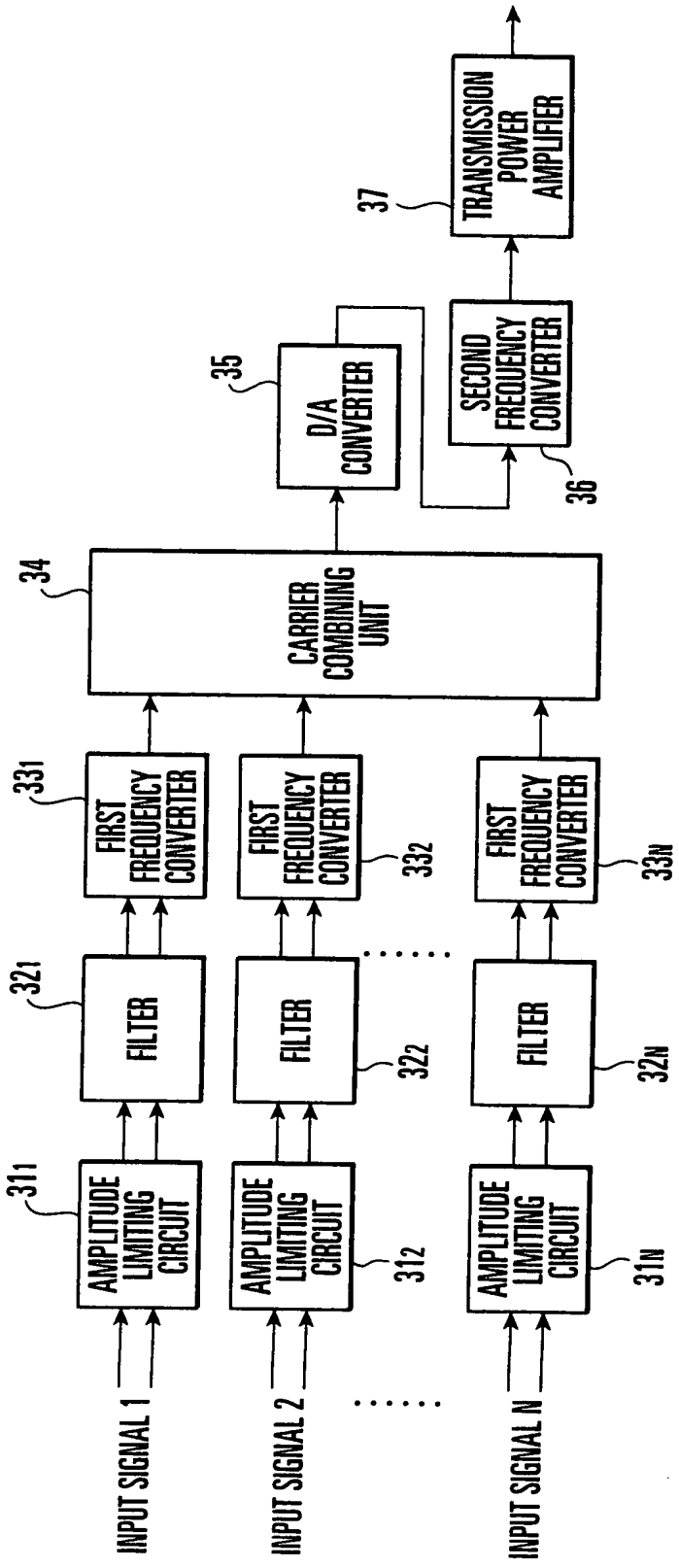

FIG. 8

PRIOR ART

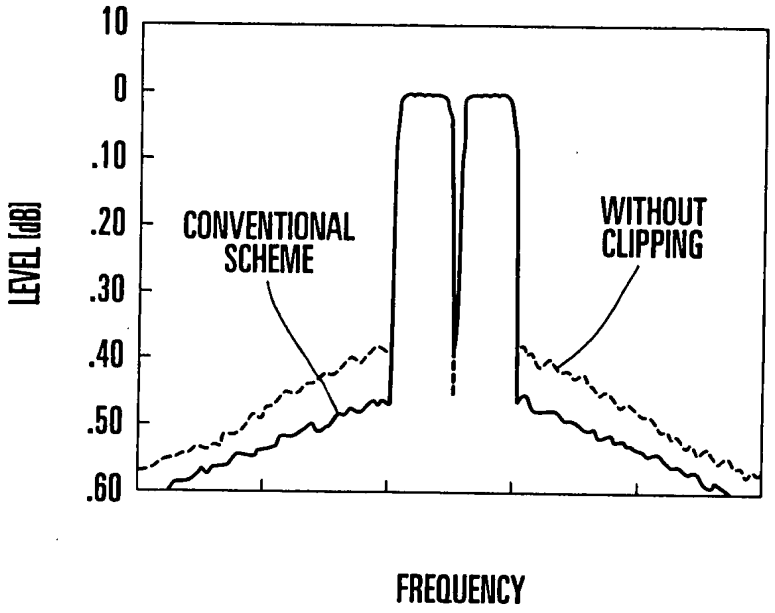

FIG. 9

PRIOR ART